Plant functinoal traits predicting the ability of tree species for restration practice of tropical montane forest, northern Thailand

	らむたい　あさのっく
氏名（本籍地）	LAMTHAI　ASANOK
学位の種類	博士（生命科学）
学位記番号	生博第２５８号
学位授与年月日	平成２５年３月２７日
学位授与の要件	学位規則第４条第１項該当
研究科，専攻	東北大学大学院生命科学研究科 （博士課程）生態システム生命科学専攻
論文題目	Plant functinoal traits predicting the ability of tree species for restration practice of tropical montane forest, northern Thailand（北タイ山地林における機能形質に基づく樹木の更新特性と森林再生への適用）
博士論文審査委員	（主査）　教授　中静　透 教授　彦坂　幸毅 教授　牧　雅之

論文内容の要旨

Plant functional traits predicting the ability of tree species for restoration practice of tropical montane forest, northern Thailand (北タイ山地林における機能形質に基づく樹木の更新特性と森林再生への適用):

To cope with the rapid decrease and fragmentation of tropical forests, in addition to slowing forest degradation, and to supporting maintenance of native biodiversity in the remaining forest fragments of the tropics, it is important to highlight the key role of ecological restoration with high biodiversity. It is also true for the mountainous areas in northern Thailand, constituting the most important watersheds in this country, which were originally covered by tropical montane forests. However, shifting cultivation by local and hill-tribe people has resulted in severe fragmentation of primary forest. Small sized primary forest fragments are now scattered among the secondary forests, and large areas of degraded forests require urgent restoration. A new approach to select tree species for reestablishment in disturbed areas is necessary in restoration practices of these areas. Utilizing functional traits of tree species are possible measures to estimate the regeneration and growth in response to environment and/or disturbance. In this study, I investigated the regeneration of tree species in forest communities that had been restored by natural regeneration across forest edge area, secondary forests and enrichment plantations, in abandoned shifting-cultivation areas and related to functional traits of these species.

In Chapter 1, I tried to test if the natural regeneration at the forest edge could be utilized for the restoration or not. In particular, the regeneration of the species occurring in primary forest was to be elucidated. I examined the main factors preventing regeneration of tree species along three belt transects covering interior-exterior gradient across the forest edges, which are different in their ages after abandonment of shifting cultivation. The naturally regenerated seedling and its spatial distribution were correlated with the physical environment and distance from seed sources. Natural regeneration of secondary forest species and generalist species could colonize better than primary forest species at exterior of forest edges, where restoration practices are required. The results suggested the difficulty for primary forest species to effectively colonize at exterior of forest edge, mostly due to recruitment limitations rather than the physical environment. Many of secondary forest species and generalists were also affected by recruitment limitation, though they were more abundant in open area with rather intensively affected by factors related to the physical environment and forest structure.

In Chapter 2, I tried to elucidate the factors to determine the regeneration success in secondary forests established after shifting cultivation, and how seedling abundance could be correlated with the functional traits of the species. I investigated naturally regenerated seedlings in a primary and two secondary forests (established after abandonment of shifting cultivation and that with enrichment plantations) of 1- ha each (totally 300 seedling quadrats of 4 m^2), and correlated them to the factors affecting regeneration success. The functional traits of tree species were also investigated and related to the regeneration success and factors affecting regeneration. The dominance of species regenerated in primary forest had significantly positive correlations with wood density and seed size, although the correlations in secondary forests and enriched plantations varied among stands. The seedlings of the species with tough leaf, large leaf mass area (LMA), and wood density were more affected by environmental conditions. Species with larger seeds tended to be more recruitment limited. These facts suggested that the restoration of primary forest species by natural regeneration is difficult because their regeneration tended to be prevented by both environmental conditions and recruitment limitation, consistent with the results of Chapter 1. The contributions of these factors in regeneration were species-dependent, and thus the regeneration success could be partly predicted by their functional traits.

Finally in Chapter 3, I repeated the census of seedlings studied in the Chapter 2 for two years to elucidate their survival and growth rate in relation to its seasonality and causal factors. The results were also correlated to the functional traits of the species. The first year and old seedling had larger mortality both in dry and rainy season, though they had faster height growth rate in rainy season. Species with low LMA, low wood density, small seed, and large, thick, and less tough leaf trended to have high mortality and rapid growth rate. They grew faster at dry and light site. The species with opposite set of traits trended to have high survival and slow growth rates, and growing relatively faster at wet and dark sites. This relationship between functional traits and environmental factors determining seedling dynamics may suggest the trade-off between mortality and growth rate; higher growth rate in light condition or high survival in dark condition. Thus, the functional traits were associated with the seedling survival and growth, and could be helpful to consider the strategies to restore forests.

My results suggest species was dominated in primary forest had a trait of higher LMA, smaller and stronger leaves, heavier wood, and large seeds, it was difficult reestablishment in disturbance area because large determining factor by both environment and recruit limitation, which extremes contract of functional trait and the factor determining with species was dominate in secondary forest. The species with high LMA larger dependent by low light suggest they

are shade-tolerance species, contract with low LMA species. The regeneration on seedling stage of high LMA species had slow growth, and large dependent by negative conspecific density and dark site. Species with dense wood had a distribution most affecting by recruit limitation and light and soil moisture, and seedling mortality and growth of them large dependent by wetter soil and dark site, and determine by negative conspecific density. Heavy wood suggest slow growth rate and late-successional characteristic. Tough leaf species had a trend similar with dense wood species suggested dense wood species may together with tough leaf. The larger and thicker leaf species, it was dominate in secondary forest and fewer determining by environment and recruit limitation. The seedling of them had high growth and mortality, and the growth large determining by dry and light site. Larger seed species, it was large determining by recruit limitation and their seedlings have high survival but slow growth rates, adapting more to wet soil and dark site.

So, my results suggested the usefulness to utilize functional traits for considering strategies and species selection in restoration practice, and I proposed an approach based on functional traits of tree species in tropical montane forests. Fundamentally, the restored degradation of tropical montane forest should be act in both natural succession and enrichment plantation, species-enrichment initiatives in disturbed areas may help to reduced recruitment limitation in forest restoration practices. After such species have successfully colonized an area they might over time influence the forest community composition and its physical environment, generating similar conditions to primary forest. I also suggested the species utilized for enrichment plantation based on their functional traits fitting the situation of degraded lands.

論文審査結果の要旨

熱帯林の保護が叫ばれて久しいが、いまだに熱帯林は減少し続けている。タイ北部の山地林でも原生林の減少は顕著であり、荒廃した森林の再生が急務である。しかし、森林再生に利用される樹種の選定や管理方法などが、生態学的な知識に基づいておらず、現在行われている森林再生の多くは成功していない。近年注目されている機能形質を利用することで、この森林再生を生態学的に効率よく行うことができると考えられるが、そのためには主要な樹木の機能形質と更新特性などの関係を明らかにする必要がある。この研究では、（1）荒廃地における樹木の更新実態を明らかにし、（2）更新実生や稚樹の分布と環境や機能形質の関係や、（3）実生の動態と機能形質との関係を明らかにすることにより、より効率的な森林再生の生態学的基礎の構築を目指した。

まず、焼畑耕作後放棄された場所に更新する樹木の実態を調査したところ、原生林の構成種は物理的環境よりは新規加入制限によって更新が妨げられている実態が明らかとなった。しかし、いくつかのパイオニア種は新規加入制限も受けず、荒廃地の環境でもよく更新していた。森林再生途上にある二次林と原生林における物理的・生物的環境条件と樹木の更新状況を調べることにより、様々な樹種の分布を制限する物理環境（光、土壌水分）が明らかとなり、その分布はそれぞれの樹木の機能特性（とくに葉面積あたりの葉重、材の比重、種子サイズ）との関連性が大きいことが明らかになった。さらに、実生の生存率や成長速度、それぞれの物理環境や生物的環境（加入制限など）に対する反応性も、機能形質と関連性が高いことが明らかとなった。これらの解明は、樹木の機能形質を実際の更新動態や環境反応性と結びつけた点で先駆的な研究であり、生態学的な知見としても評価できる。さらに、著者はこれらの結果をもとに、実際の森林再生における樹種選択や管理方法について、樹木の機能形質を基礎とした方法で提言しており、応用的な価値も高い研究となっている。

以上の内容は、自立して研究活動を行うに必要な高度の研究能力と学識を有することを示している。したがって，Lamthai Asanok 提出の論文は，博士（生命科学）の博士論文として合格と認める。